

Identifying Geographic Areas at Risk of Soil-transmitted Helminthes Infection Using MODIS Products: Boaco, Nicaragua as a Case Study



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NSSTC/MSFC/NASA**



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Presentation Overview



- **Background of the Diseases**
 - Neglected Diseases
 - Sanitation
 - Health Impact
- **Study Area**
 - Boaco, Nicaragua
- **Remote Sensing**
 - MODIS Land Surface Temperature (LST)
 - MODIS Normalized Difference Vegetation Index (NDVI)
 - MODIS Land Cover Land Use Type (LCLU)
- **Results**
- **Conclusions**
- **Future Studies**

Background



Source: Thor Axel Stenström, 2009

- Environment is a major factor for health, both directly or indirectly
 - Sanitation, poverty, neglected diseases
 - Natural environment
- A number of agents of diseases are carried by vectors and reservoirs whose viability depends on given environmental conditions
- Such conditions describe not only the characteristics of the natural environment but also of sanitation
- Such conditions can be inferred with satellite data
 - Temperature
 - Presences of water bodies
 - Soil moisture
 - Vegetation
 - Elevation
 - Precipitation

Background cont.



- Soil transmitted helminthes infection, Helminthiasis, Neglected Diseases
- Impact
 - Reduced physical growth
 - Weak physical fitness
 - Impaired cognitive functions
 - Increase with intensity of infections

Background cont.

- Microscopic Evaluation

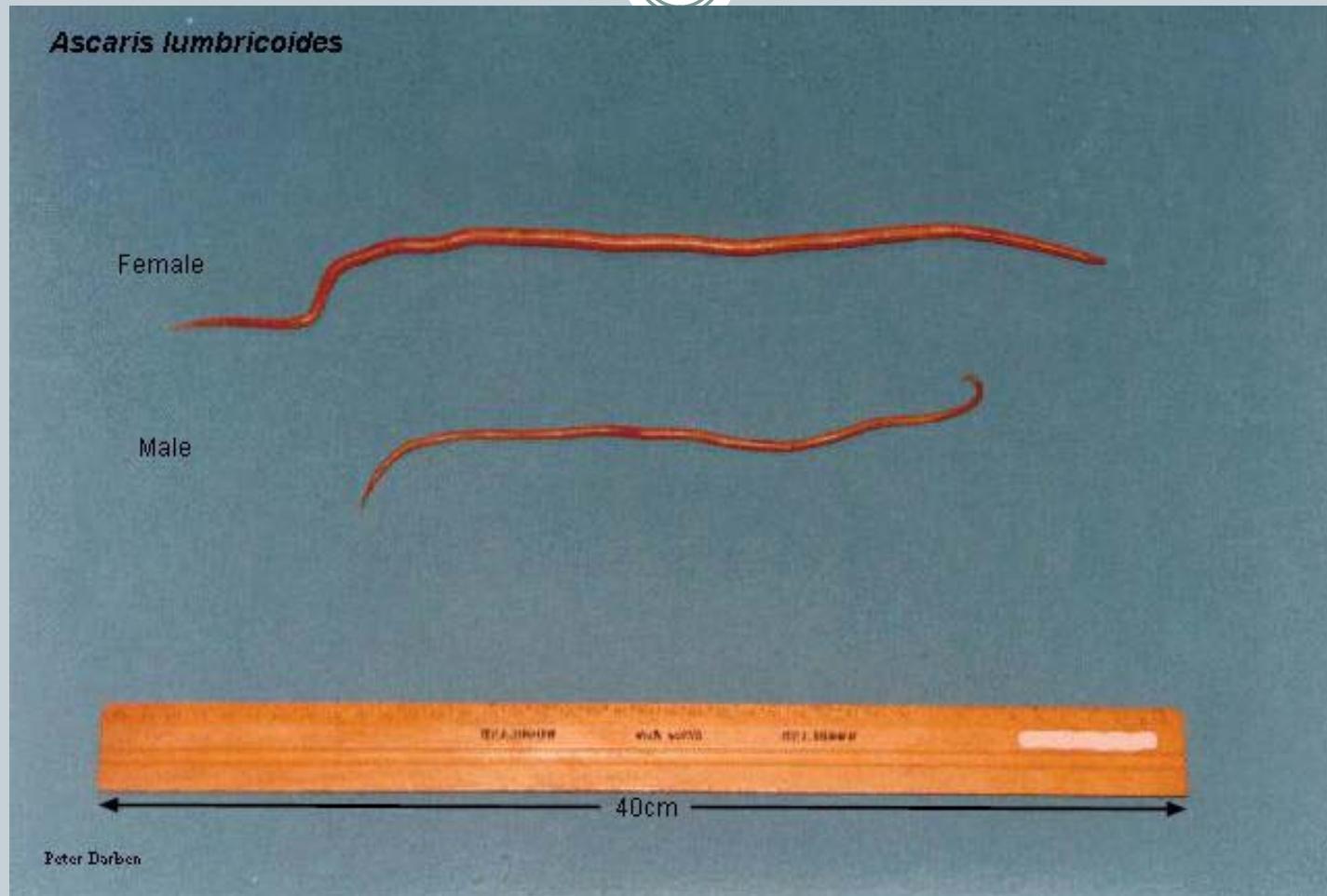


Ascaris suum zygotes
inactivated



Ascaris suum developed
larva

Background cont.



http://curezone.com/image_gallery/parasites/ascaris/

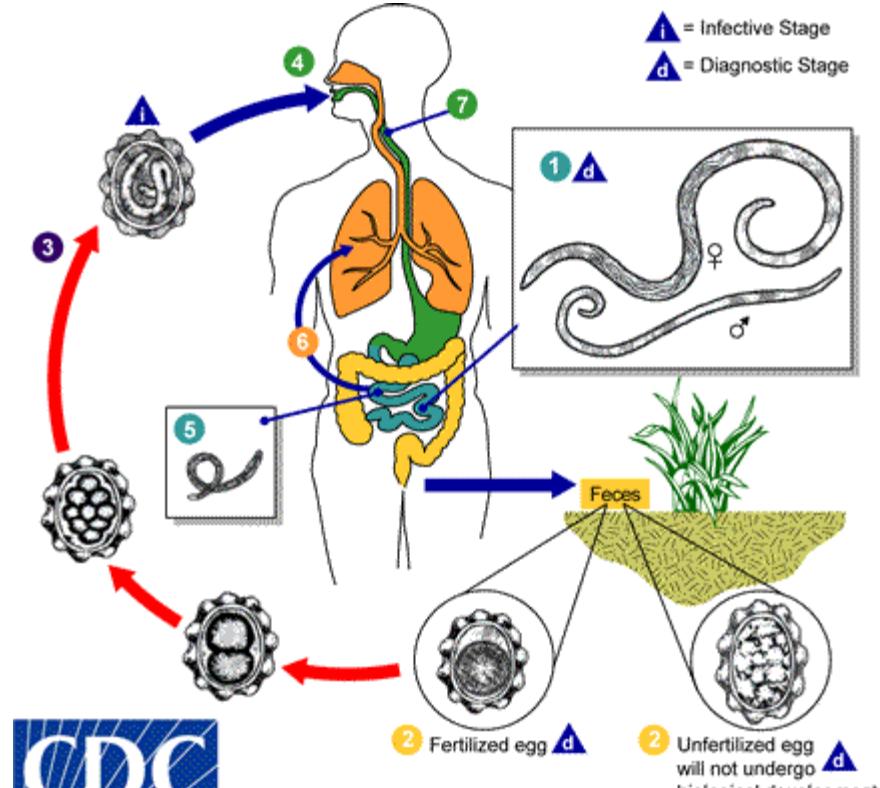
Background cont.

Ascaris lumbricoides

Life cycle

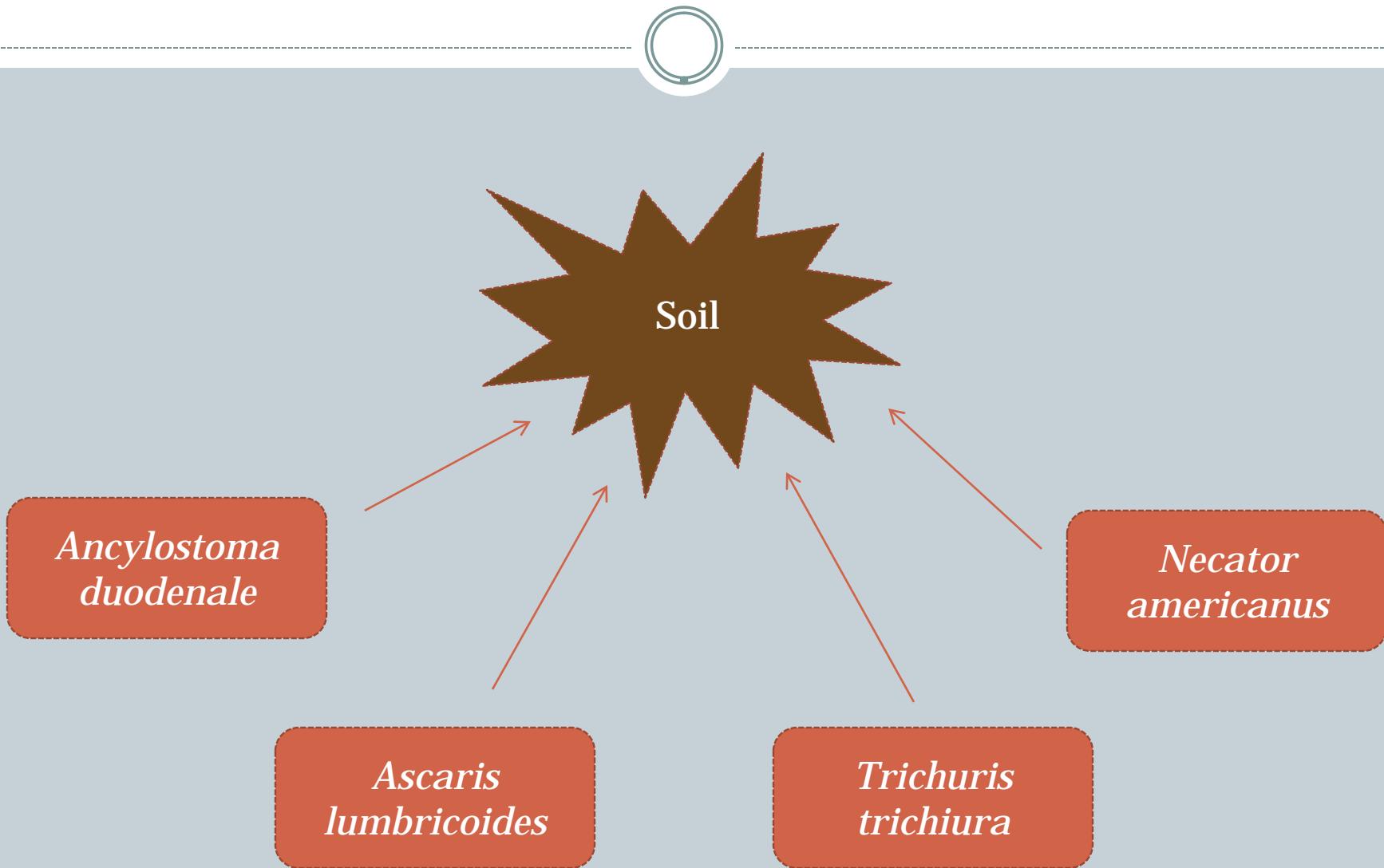
2 to 3 months after
ingestion of the eggs,
the mature worms
commence egg laying
in the intestine

2 or 3 weeks outside the
host to develop to the
infective stage



<http://www.dpd.cdc.gov/dpdx>

Background cont.

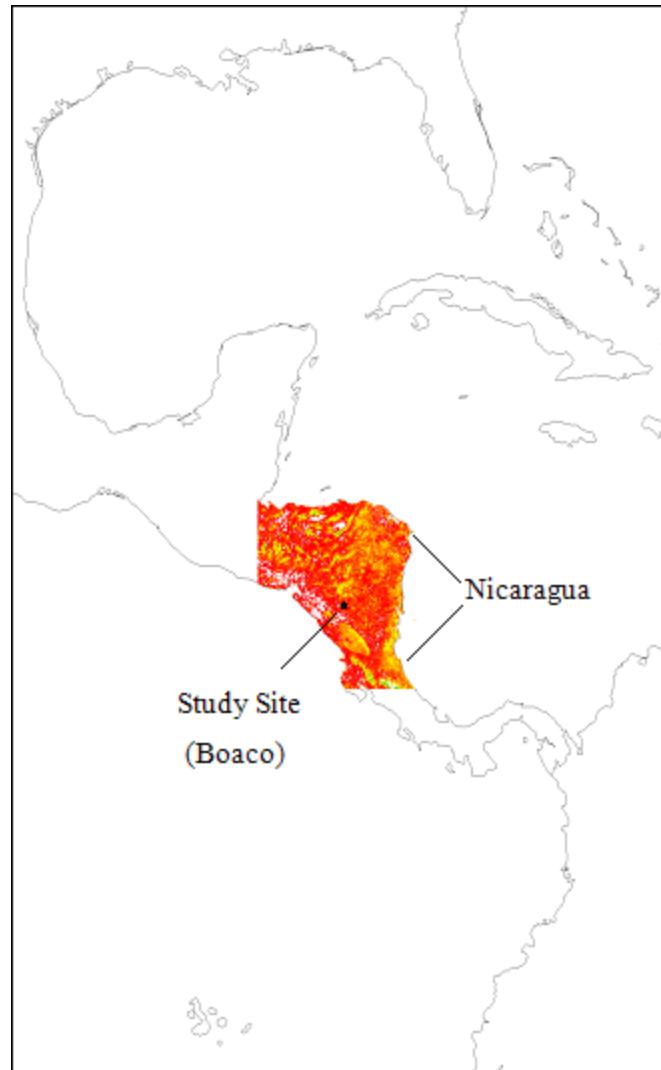
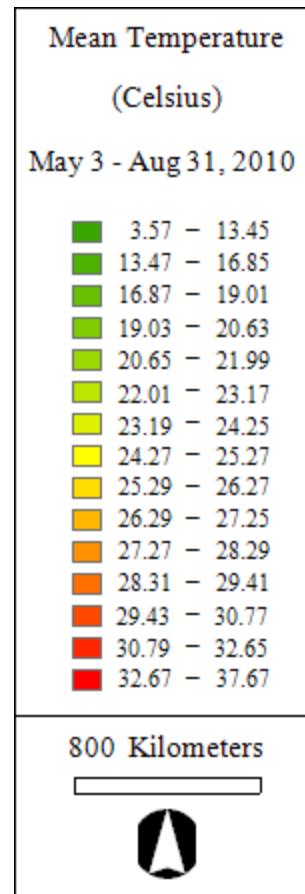


Study Area

Ascaris lumbricoides
Trichuris trichiura
Ancilostoma duodenale

MODIS Land Surface
Temperature (LST)
1:30 pm

MYD11A1 1 km daily



Study Area

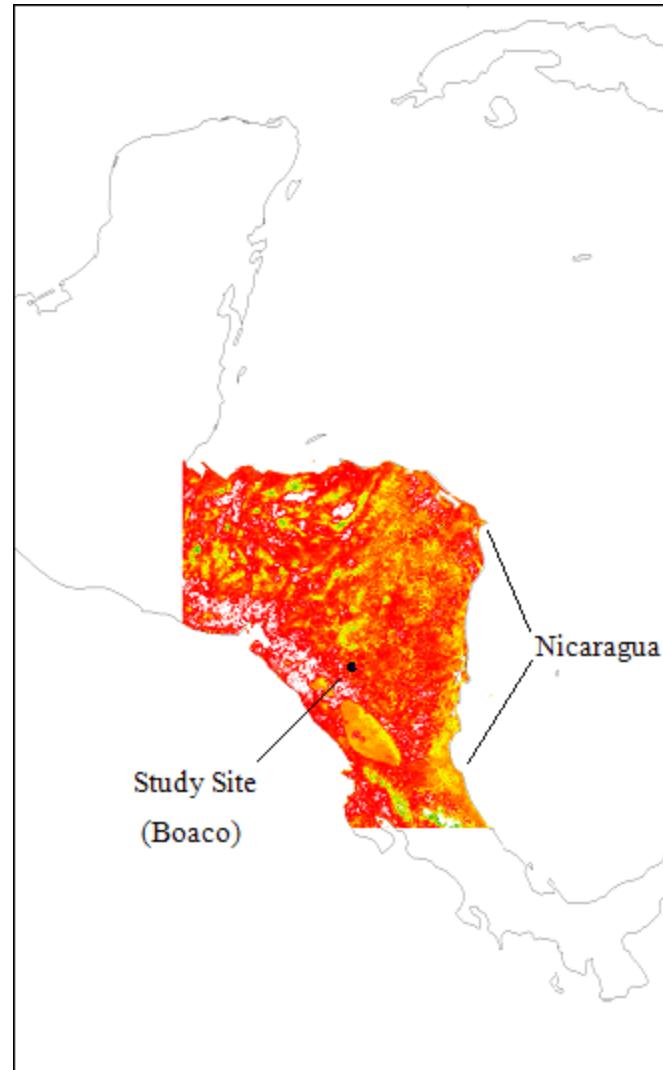
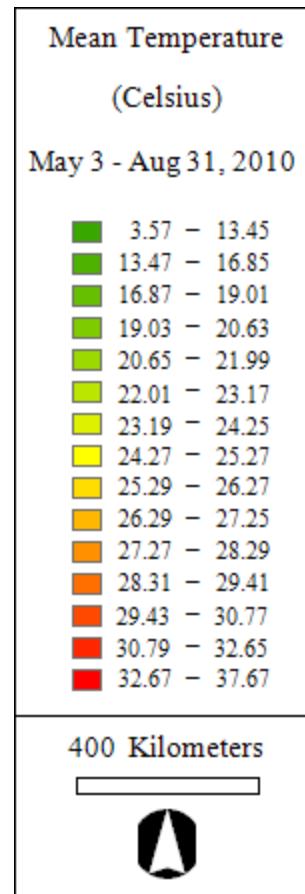
Ascaris lumbricoides

Trichuris trichiura

Anclostoma duodenale

MODIS Land Surface
Temperature (LST)
1:30 pm

MYD11A1 1 km daily

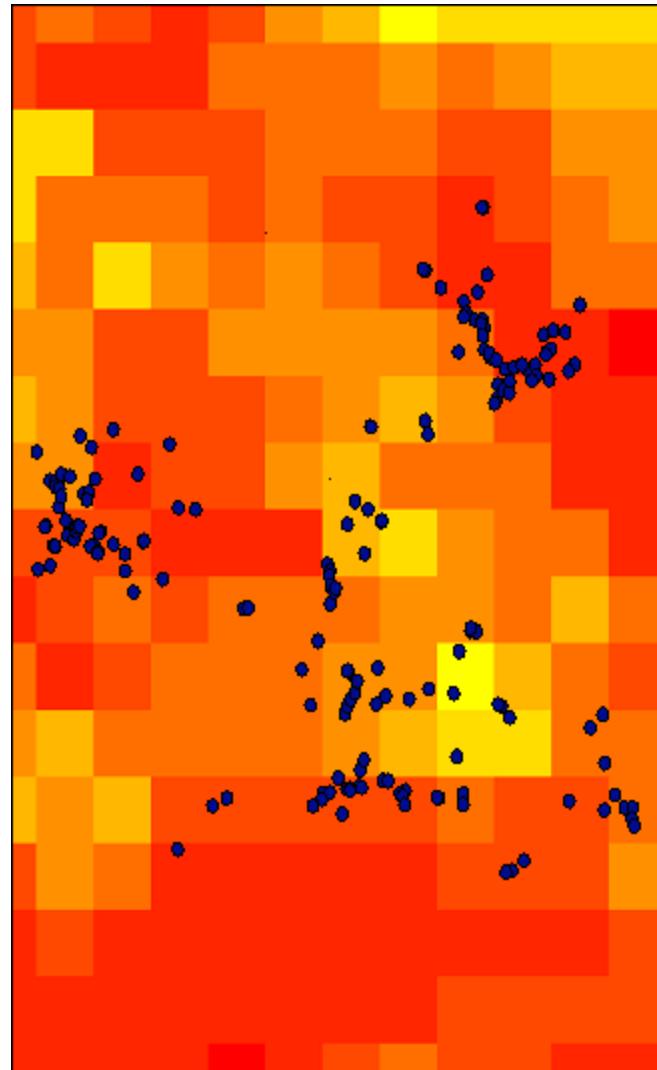
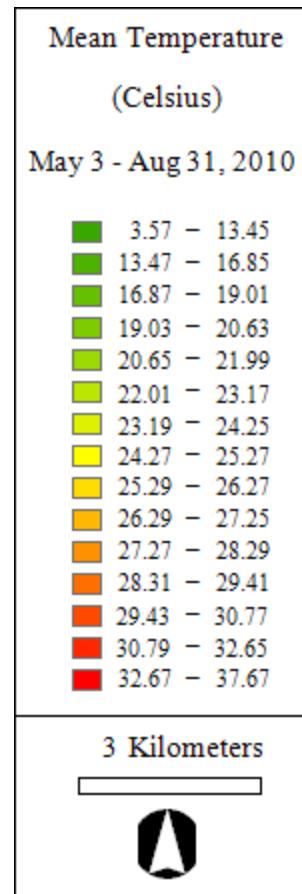


Remote Sensing

Ascaris lumbricoides
Trichuris trichiura
Ancilostoma duodenale

MODIS Land Surface
Temperature (LST)
1:30 pm

MYD11A1 1 km daily



Remote Sensing

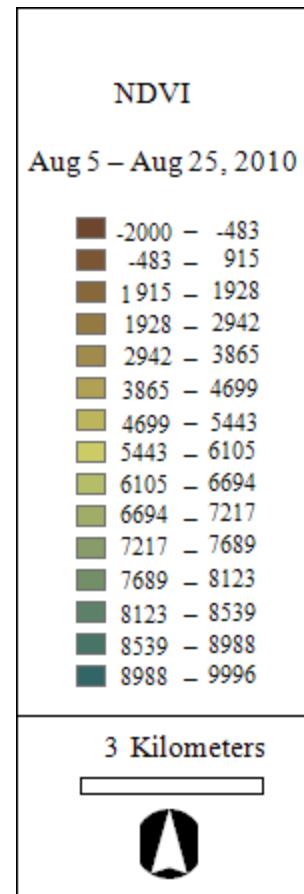
Ascaris lumbricoides
Trichuris trichiura
Anclostoma duodenale

MODIS Normalized
Difference Vegetation
Index (NDVI)

MYD13Q1

250 m

16 day



Remote Sensing

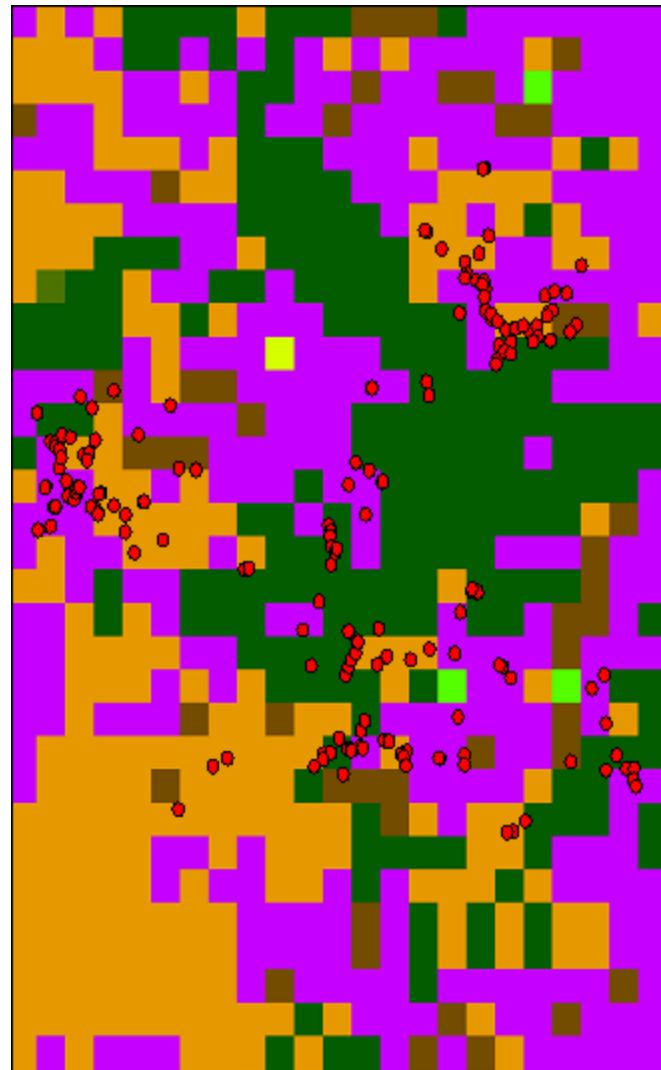
Ascaris lumbricoides
Trichuris trichiura
Ancilostoma duodenale

MODIS Land Cover
Land Use Type (LCLU)

MCD12Q1 Combined

500 m

Yearly



LST

Thrichuris trichuria

Wilcoxon Two-Sample Test:

Normal Approximation

$\Pr > |z| = 0.0157$

t Approximation

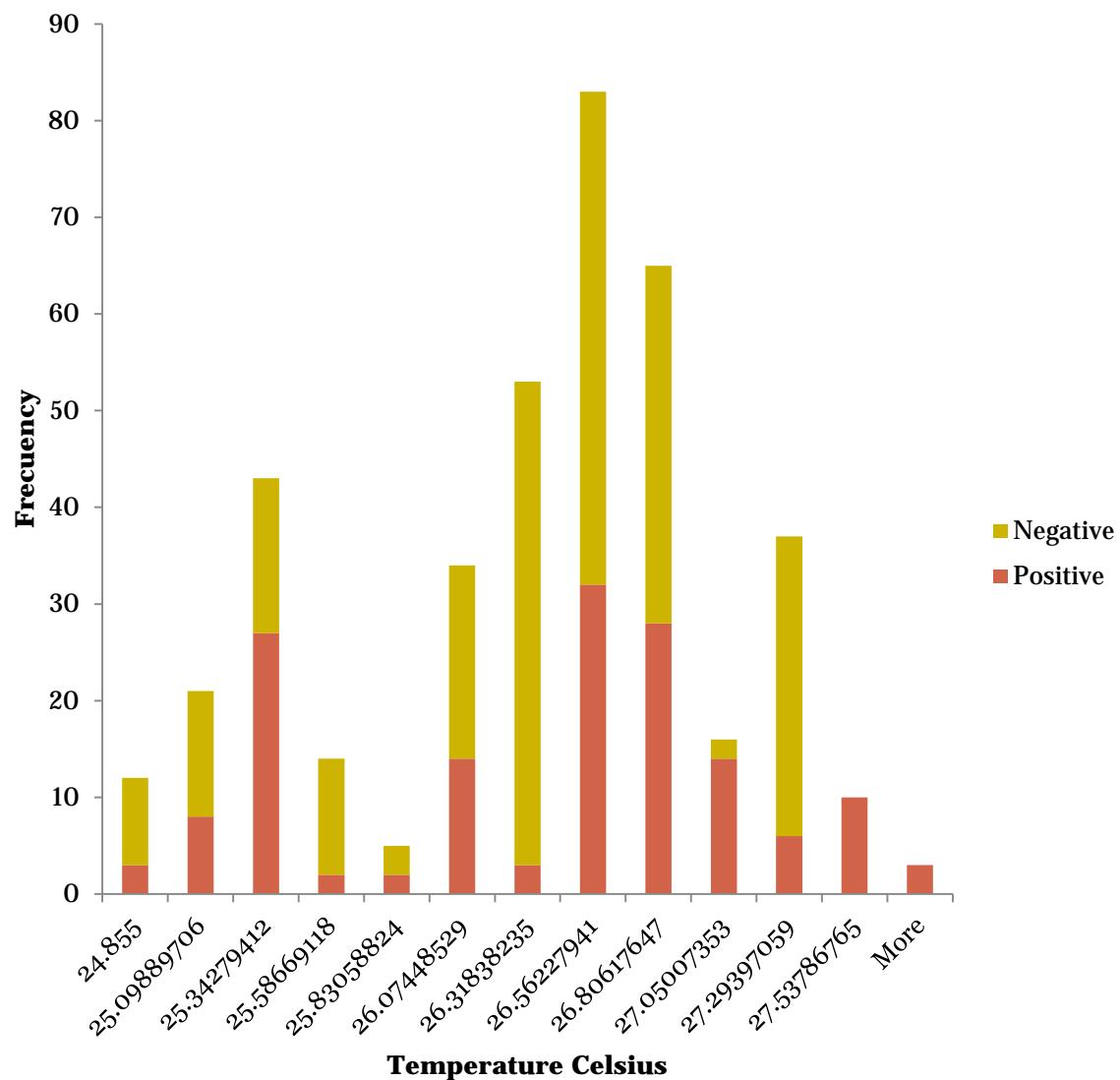
$\Pr > |z| = 0.0161$

Kruskal-Wallis Test

$\Pr > \text{Chi-Square} = 0.0156$

Positive: n=152
mean=26.27

Negative: n=244
mean=26.47



LST *Ascaris lumbricoides*

Wilcoxon Two-Sample
Test:

Normal Approximation

$\Pr > |z| < 0.0001$

t Approximation

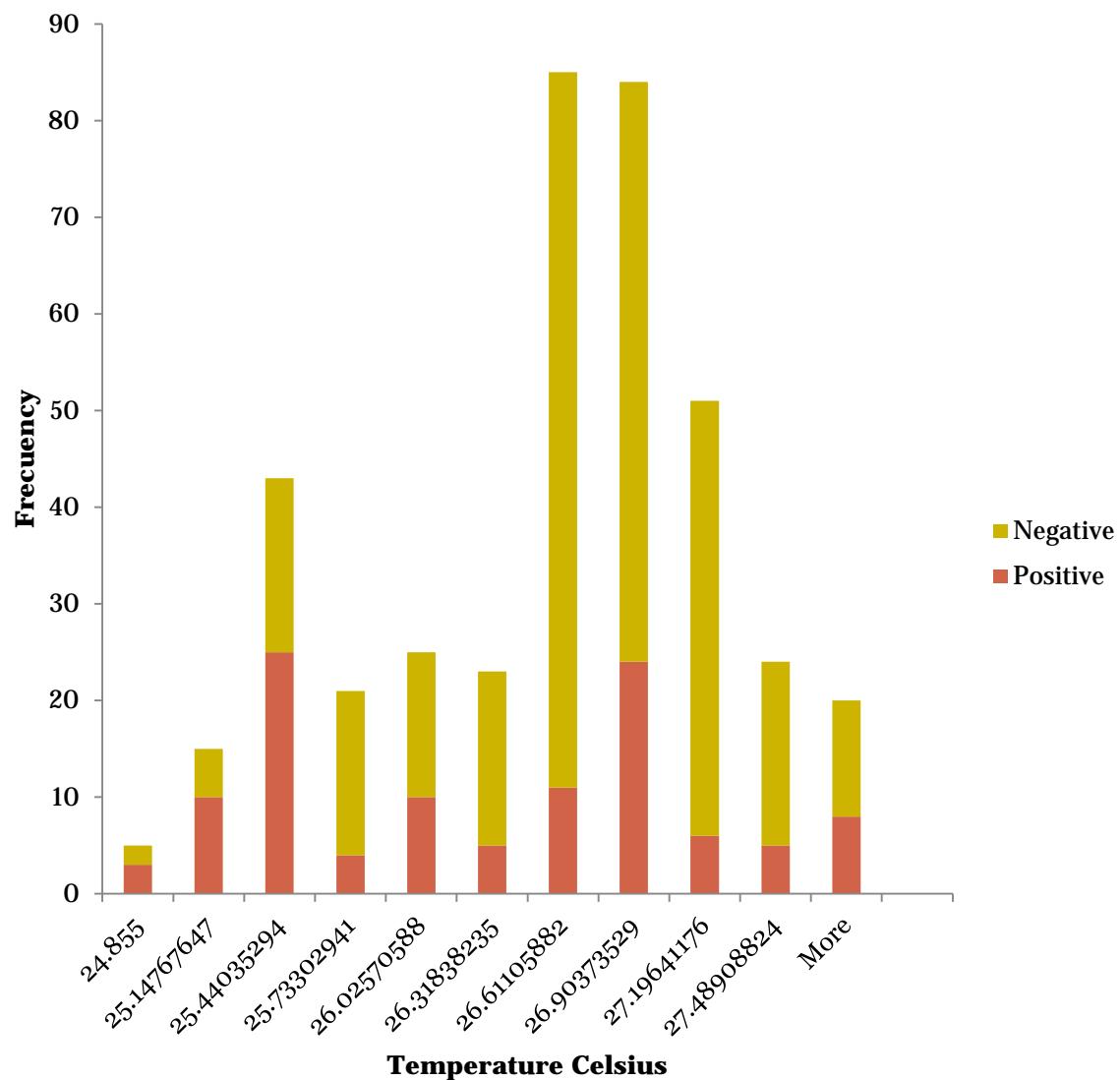
$\Pr > |z| < 0.0001$

Kruskal-Wallis Test

$\Pr > \text{Chi-Square} < 0.0001$

Positive: n=111
mean=26.13

Negative: n=285
mean=26.49



LST

Ancilostoma duodenale

Wilcoxon Two-Sample Test:

Normal Approximation

$\Pr > |z| = 0.7824$

t Approximation

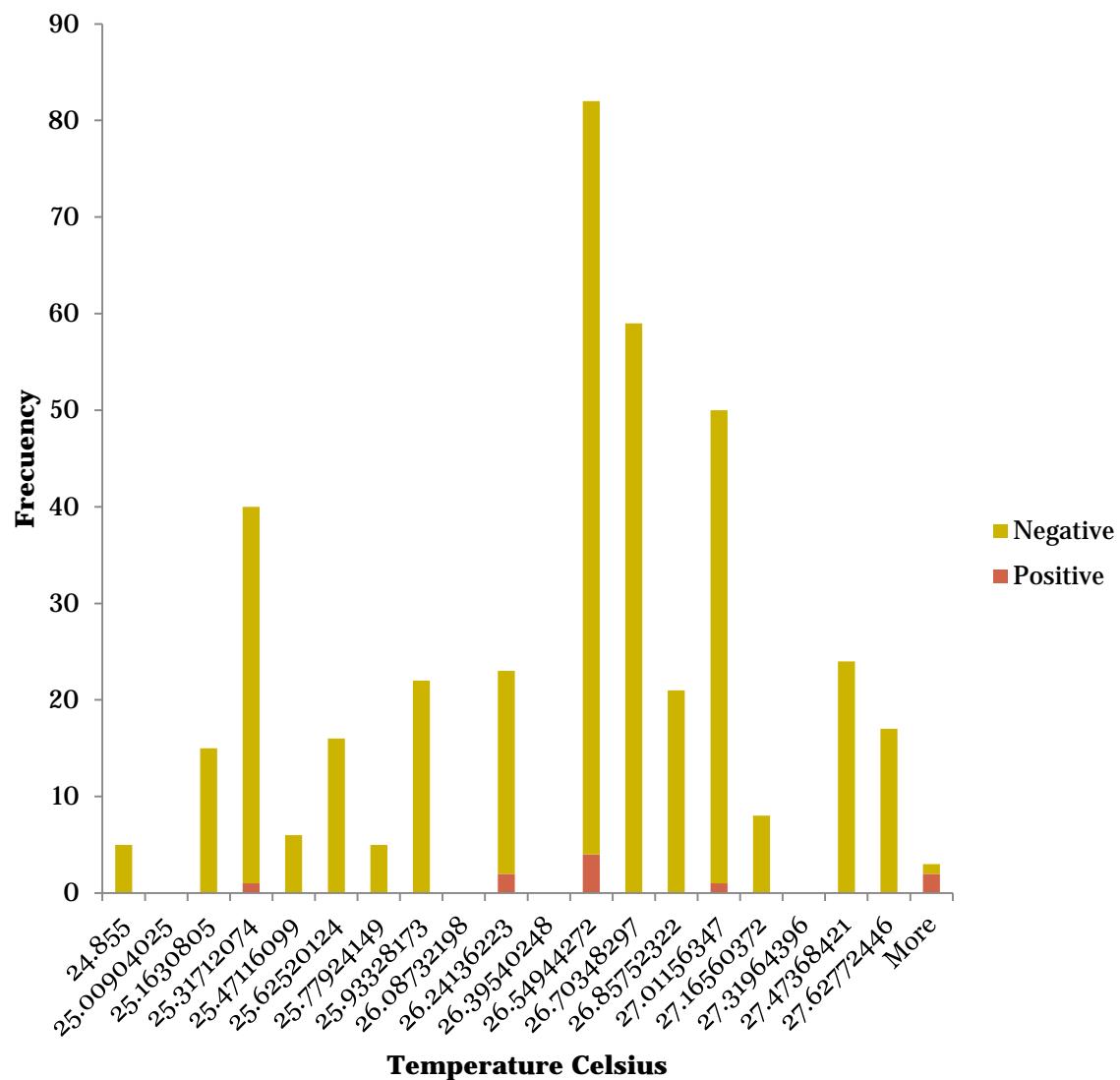
$\Pr > |z| = 0.7825$

Kruskal-Wallis Test

$\Pr > \text{Chi-Square} = 0.7813$

Positive: $n=10$
mean=26.61

Negative: $n=386$
mean=26.39



NDVI

Trichuris trichuria

Wilcoxon Two-Sample Test:

Normal Approximation

$\Pr > |z| = 0.029$

t Approximation

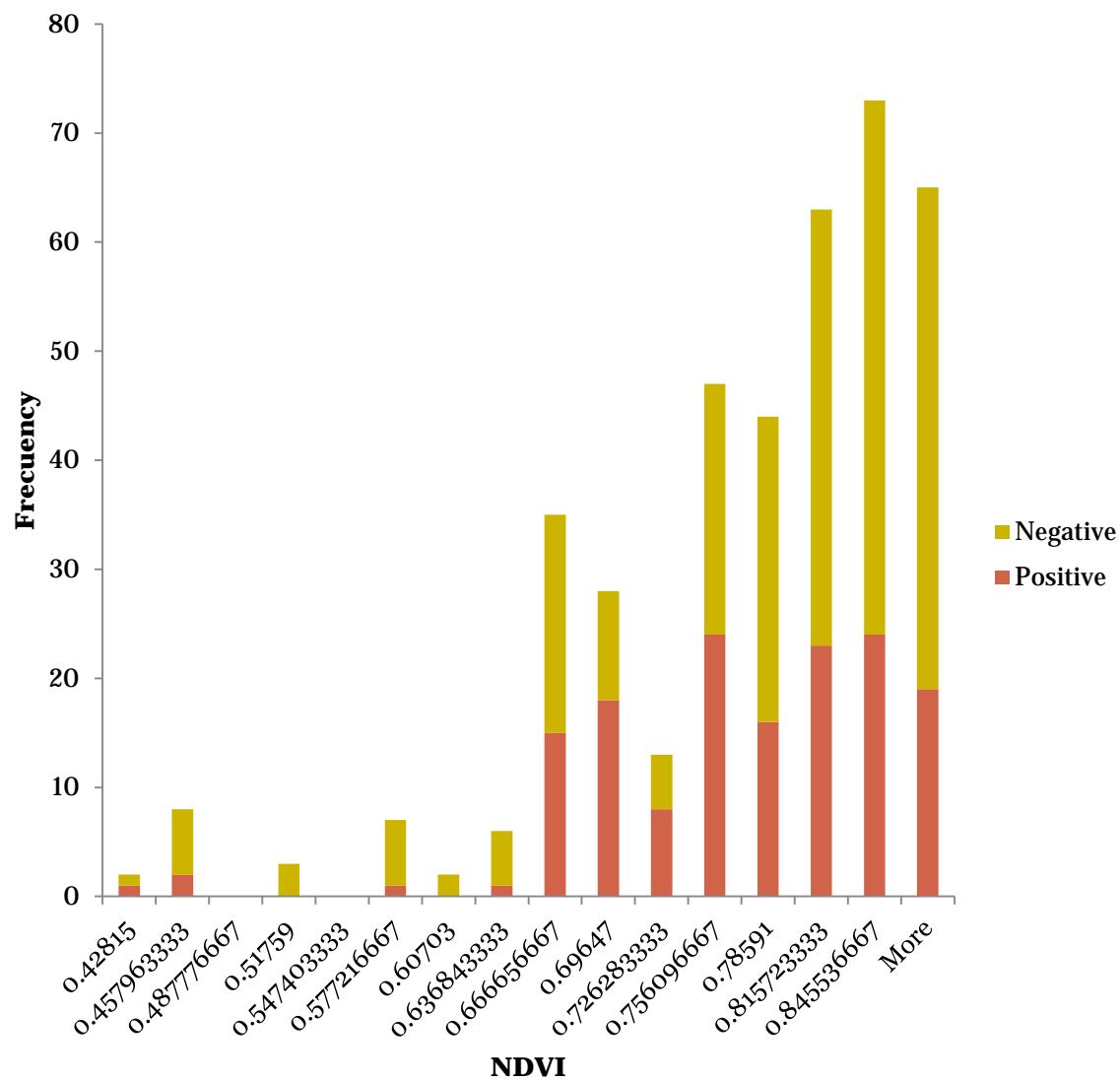
$\Pr > |z| = 0.0301$

Kruskal-Wallis Test

$\Pr > \text{Chi-Square} = 0.295$

Positive: $n=152$
mean=0.756

Negative: $n=244$
mean=0.765



NDVI

Ascaris lumbricoides

Wilcoxon Two-Sample Test:

Normal Approximation

$\Pr > |z| > 0.6$

t Approximation

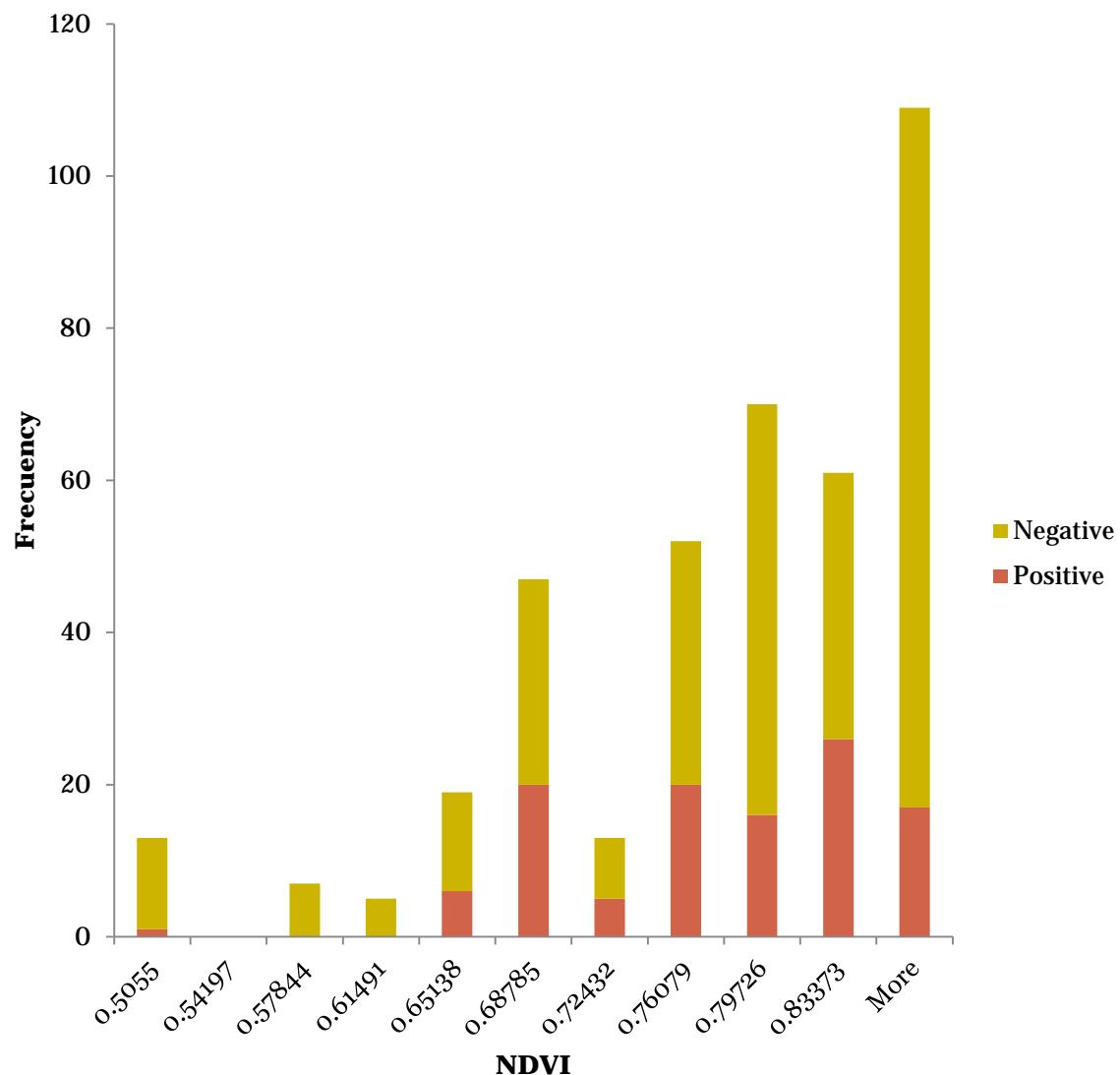
$\Pr > |z| > 0.1054$

Kruskal-Wallis Test

$\Pr > \text{Chi-Square} > 0.1045$

Positive: n=111
mean=0.760

Negative: n=285
mean=0.761



NDVI

Ancilostoma duodenale

Wilcoxon Two-Sample Test:

Normal Approximation

$\Pr > |z|$ 0.7656

t Approximation

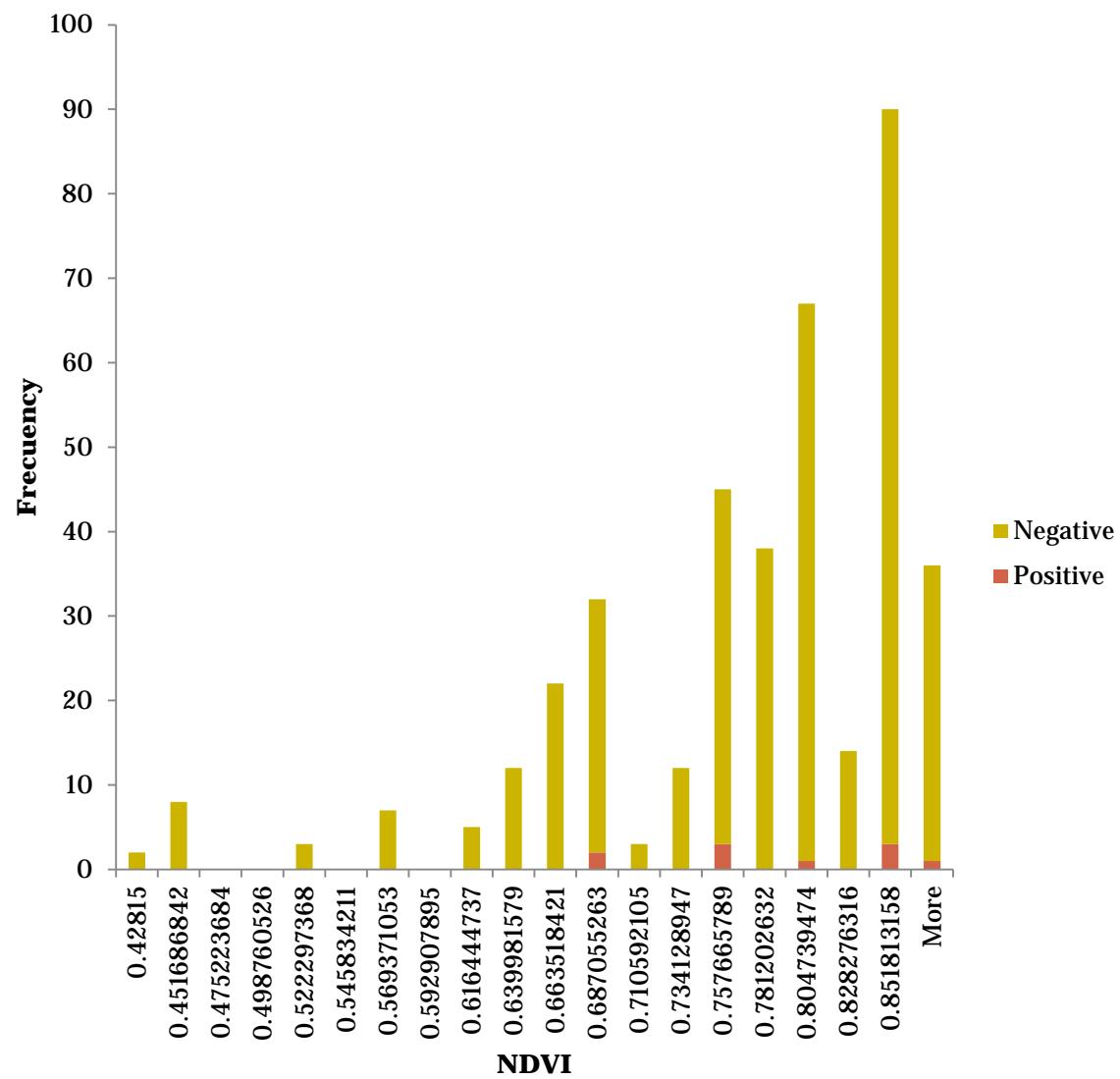
$\Pr > |z|$ 0.7658

Kruskal-Wallis Test

$\Pr >$ Chi-Square 0.7646

Positive: n=10
mean=0.777

Negative: n=386
mean=0.761



Wilcoxon Two-Sample Test:

Normal Approximation

$\Pr > |z|$ 0.7656

t Approximation

$\Pr > |z|$ 0.7658

Kruskal-Wallis Test

$\Pr >$ Chi-Square 0.7646

Positive: $n=10$
 $\text{mean}=0.777$

Negative: $n=386$
 $\text{mean}=0.761$

Land Class	Posit.	Negat.	Odd ratio	n	Prevalence
2	44	54	0.814	98	0.45
8	48	69	0.695	117	0.41
12	6	10	0.6	16	0.37
14	91	74	1.23	165	0.55



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